



## RESULTS FROM A JOINT NASA AND RUSSIAN FIELD TEST OF SENSORIMOTOR AND CARDIOVASCULAR FUNCTION FOLLOWING LONG DURATION SPACEFLIGHT



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PHOTO CREDIT: NASA

In Memoriam: Dr. Donald E. Parker, 1937-2016



## General Observations



1. Every Returning Crewmember Exhibits Vestibular/Cerebellar Sensorimotor Symptoms.
2. Every Crewmember Experiences Some Degree of Reentry or Landing Motion Sickness.
3. Considerable Variance Across Crewmembers' Functional Performance.
4. Multiple Test Sessions on R+0 Appears to be Beneficial: Enhancing Readaptation.



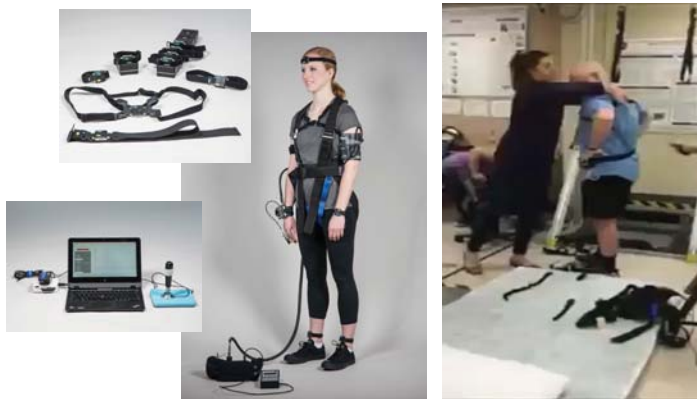
## Field Test Protocols



\* Indicates Tests Covered  
In This Presentation



## Hardware and Instrumentation

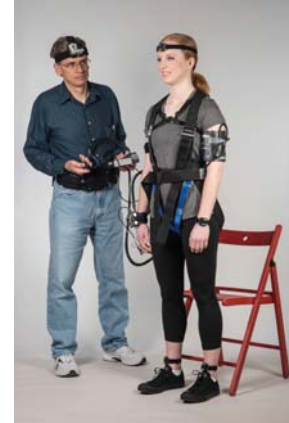
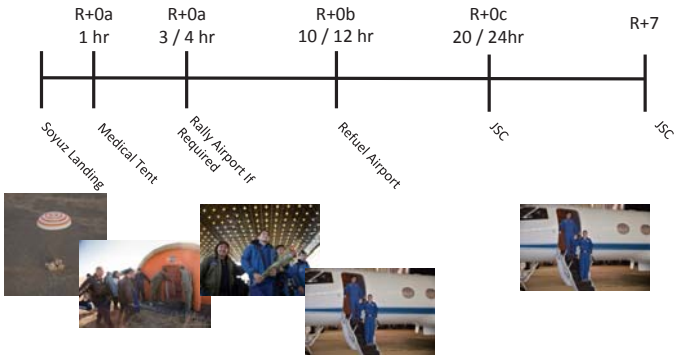




## Testing Sequence - Timeline



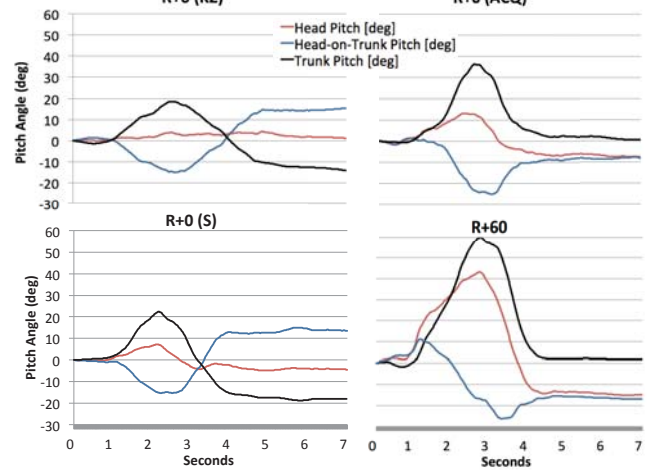
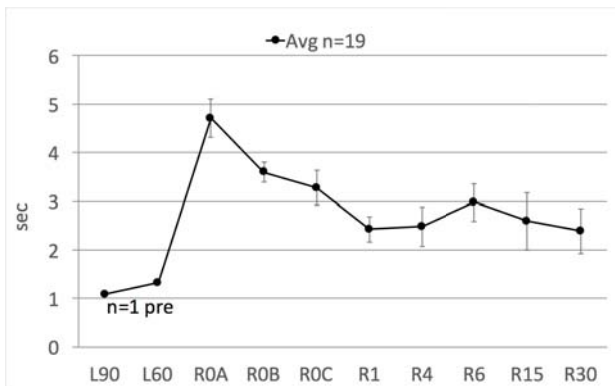
## Sit-to-Stand



## Sit-to-Stand Time To Stability



## Sit-to-Stand Pitch Angles

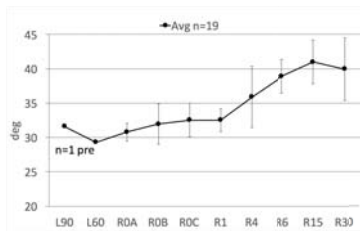




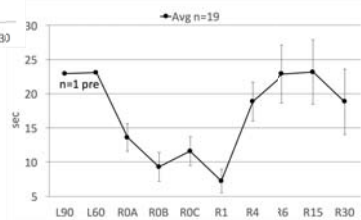
## Sit to Stand



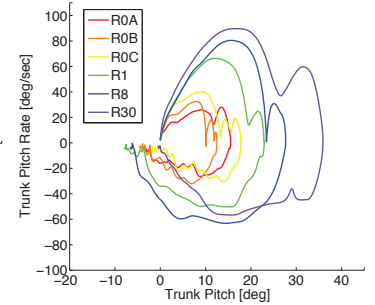
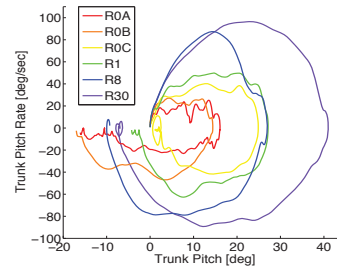
Head Pitch Range



Trunk Pitch Range



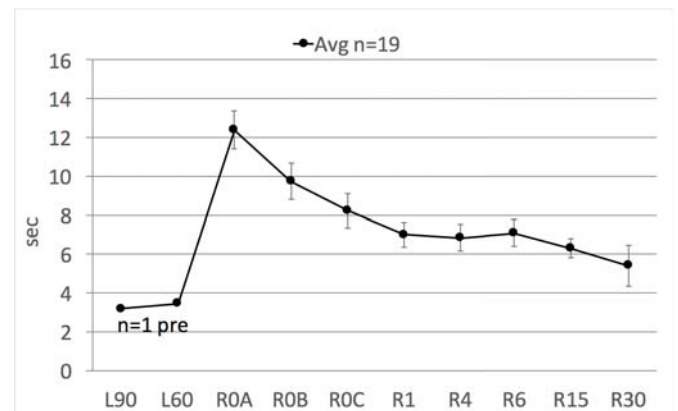
## Sit to Stand: Phase Plane



## Recovery From Fall

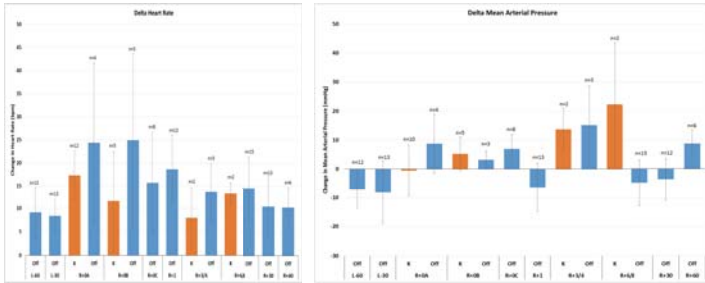


## Recovery from Fall: Time to Stability

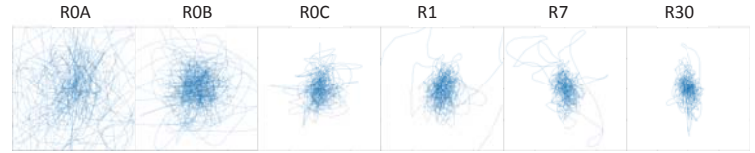




## Cardiovascular Stand Test: Recovery From Fall



## Stabilograms During Recovery From Fall and Quiet Stance



0.1 m/s<sup>2</sup>  
A/P  
0.1 m/s<sup>2</sup>  
M/L

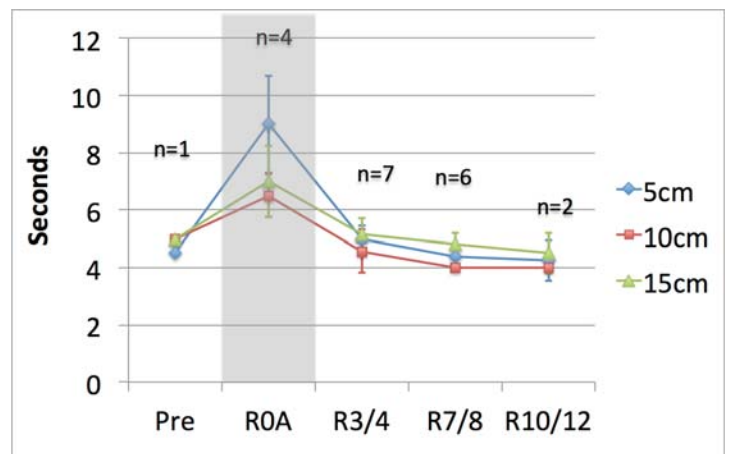
Stabilograms from lumbar acceleration traces (mediolateral [ML] vs. anteroposterior [AP]) recorded on one crewmember over a 30-day postflight period. Each panel shows the first 20 seconds of quiet stance accelerations filtered using a 2<sup>nd</sup> order Butterworth filter with 10-Hz cutoff frequency.



## Walk With Obstacle



## Step Over: Time to Completion

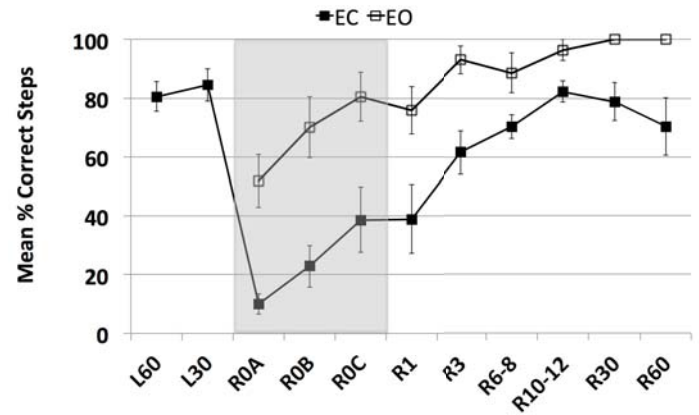




## Tandem Walk



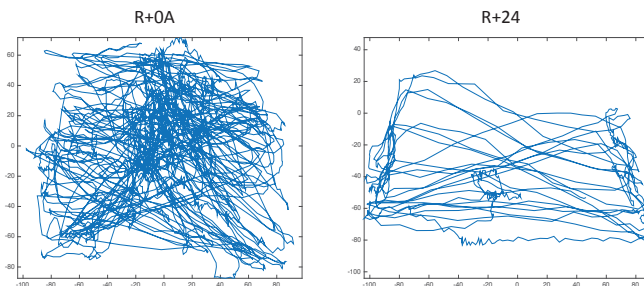
## Tandem Walk: Percent Correct Steps Eyes Closed vs. Eyes Open



## Tandem Walk-Step Organization Depicted As Median Force (COP) Over Time



## PFT Protocols: Performance



Tests Completed in Field/KZ AP on R+0	Subject Count
Sit-to-Stand, Recovery from Fall, Tandem Walk	9
Sit-to-Stand, Recovery from Fall	6
Sit-to-Stand	1
No tests completed	2
	18

IN ADDITION, 4 OF 7 COSMONAUTS WERE ABLE TO COMPLETE 2 ADDITIONAL TESTS IN THE FIELD (PUSH TEST AND SEAT EGRESS OBSTACLE TEST).



## Field Test Intent and Relevance



- 1) Allows development of a time constant for functional performance in the hours and days following long duration spaceflight.
- 2) Allows evaluation of NASA's GCG and the Russian Kentavr garment for protection against landing orthostatic intolerance.
- 3) Allows development of a knowledge base from which programmatic risks for interplanetary travel can be developed:
  - a. Safety and functional performance upon landing on a planetary (Mars?) surface.
  - b. Water landing in the Orion capsule.
  - c. More immediate: Soyuz egress following a ballistic entry beyond anticipated landing point.